

# IMPLEMENTATION OF SAFETY MEASURES IN STONE QUARRIES

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Safety measures in stone quarries are investigated through a questionnaire for safety requirements and the degree of compliance distributed to managers and workers of selected quarries in northern Jordan. Responses showed that while health and technical safety measures are applied in most quarries, safety awareness measures are unimplemented in all surveyed quarries despite the claim by quarry managers and workers that awareness programs do exist. Preliminary results indicate a correlation between the level of education and experience of both quarries managers and workers and the frequency and severity of work accidents.

*Keywords:* Safety assurance, Health safety, Technical safety, Awareness safety.

## 1 INTRODUCTION

Quarries constitute major safety hazards to workers and have a negative impact on the surrounding environment. They involve risky operations including crushing, blasting, and the extensive use of heavy equipment such as jackhammers, dozers, crushers, loaders and trucks (Maier 2000). Quarries must apply safety assurance requirements in the site to have a safe working environment. Safety requirements include but are not limited to safety awareness, providing safety tools, first aid, safe usage of equipment and vehicles, safety supervision, etc. Conchie et al. (2013) investigated the importance of supervisors' safety leadership in promoting employees' engagement in safety. Yarahmadi et al. (2014) showed that risk assessment is an important consideration in mines, and should be accompanied with adjustment approaches. Patrick et al. (2013) listed the skills project management team should develop to manage construction safety risks, implement safety tasks, and develop safety climate. Ersoy (2013) studied the importance of occupational safety of 10 marble quarries in Anatolia. Accident and safety quarry indexes were calculated by the Analytic Hierarchy Process method to determine the weight of the accident risks and the safety measures. A negative exponential relationship has been identified between accident and safety indexes in quarries, reflecting the importance of safety measures in reducing accidents.

## 2 METHODOLOGY

A questionnaire was designed to assess the safety programs and practices at quarries as seen by management and workers. The questionnaire consisted of two parts: the first pertained to respondent's qualifications, working experience, and prior accidents; the second part was about personal safety issues. The personal safety part was divided into

awareness issues, health issues, and technical issues. In response to the degree of compliance with the issue in question, respondents were provided with four choices to each question: always, most of the time, sometimes, and never. The questionnaire was distributed to managers and workers in 12 quarries in Amman and Irbid governances in northern Jordan. The researcher arranged for a visit to each site and held an interview with the quarry manager. The process was repeated with two of the quarry workers.

The questionnaire was analyzed to determine the level of safety requirements at different quarries, and to determine if there was any difference between safety practices in Amman and Irbid. Results analysis was done by weight method. The average weight for each performance indicator reflected its compliance or importance.

### **3 RESULTS AND DISCUSSION**

#### **3.1 Education, Experience and Injuries**

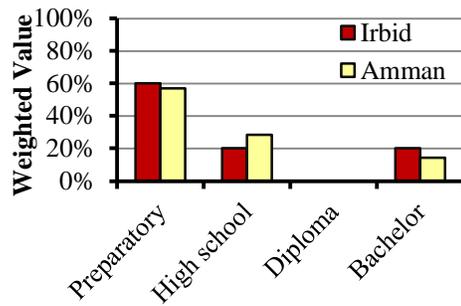
The level of education is divided into four categories: preparatory school, high school, high-school diploma, and bachelor's degree. The results, shown in Figures 1(a) and 1(b) for managers and workers respectively, revealed the low education level of most workers, especially those working the Irbid quarries; about 90% of them had preparatory school education, but only about 10% hold a diploma. Workers in Amman quarries were slightly higher, with 70% having preparatory school education and 5% holding a bachelor degree. The level of education for quarry managers was not much different, with similar results for workers of Amman and Irbid quarries. In general, 20% of Irbid managers hold bachelor degrees while 14.3% of Amman managers did.

Another factor is experience. The experience of managers and workers of Irbid and Amman quarries is shown in Figures 1(c) and 1(d), respectively. As can be seen, managers and workers of Amman quarries are more experienced than those in Irbid quarries. From this we can conclude that worker retention in Amman quarries is much higher than that of Irbid's, and thus less expected to be prone to accidents.

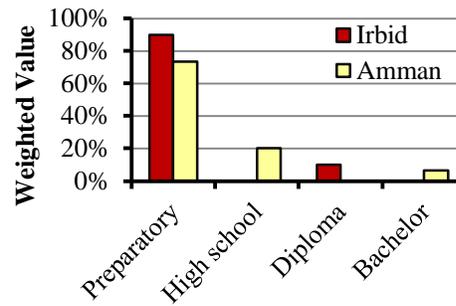
The weighted percentage of the levels of suffered injuries according to managers and workers of Irbid and Amman quarries are in Figures 1(e) and 1(f), respectively. It can be seen that managers of Irbid and Amman quarries reported lower rates of injuries than workers. None of the responding managers in Irbid quarries reported injuries, while 14.3% of managers in Amman quarries reported medium injuries. Contrary to the managers, 40% of responding workers in Amman quarries reported medium injuries, and none reported serious injuries. These percentages for Irbid quarries are 40% and 10% for medium and serious injuries respectively. It is apparent that Irbid quarry workers are more prone to serious injuries than their counterparts in Amman. This can be attributed to lower level of education and less experience.

#### **3.2 Personal Safety**

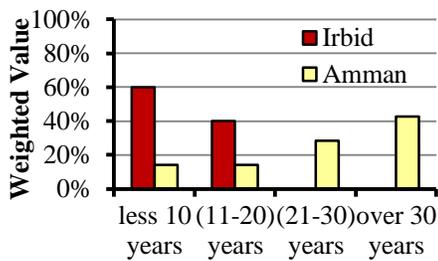
Personal safety is defined as the freedom from physical harm or threat of physical harm, freedom from hostility, aggression and harassment (Conchie et al. 2013). This safety is affected by the working environment, job conditions, technical issues and safety awareness of managers and workers. The questionnaire regarding personal safety was thus divided into three categories: health safety, technical safety, and safety awareness.



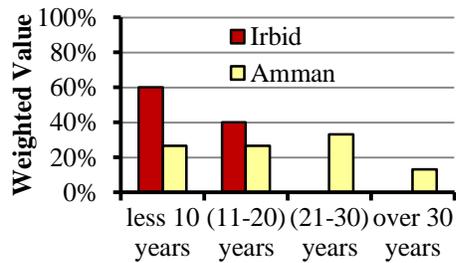
(a) Education level of managers.



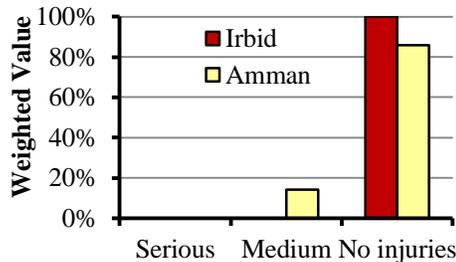
(b) Education level of workers.



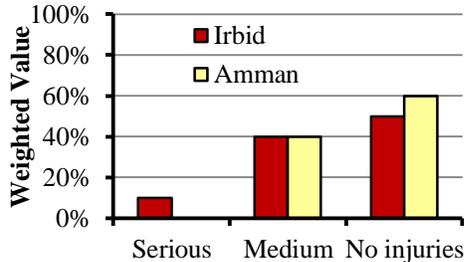
(c) Experience of managers.



(d) Experience of workers.



(e) Injuries as reported by managers.

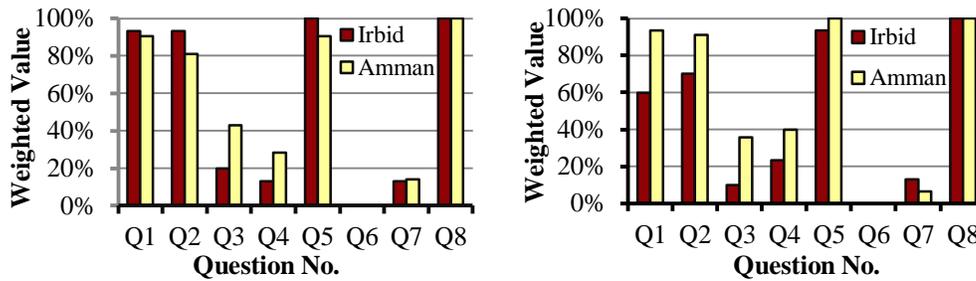


(f) Injuries as reported by workers.

Figure 1: Weighed percentages for education, experience, and witnessed injuries.

### 3.2.1 Health Safety

Health safety is surveyed through responses to eight questions and the results of the survey are shown in Figures 2(a) and 2(b) for managers and workers, respectively. The figures show minor differences between workers' and managers' responses. The presence of a supervisor for occupational safety at the quarry site was the subject of the first question. The weighted average of workers in Irbid quarries' response was only 60%, managers 93%. This does not seem to be the case for Amman quarries; the responses of managers and workers are similar with a weighted average of over 90%.



a) Health safety as reported by managers.

b) Health safety as reported by workers.

Figure 2: Weighted percentages of applying health safety.

Questions 2, 3, and 4 pertain to the respective availability, degree of use, and degree of enforcement for the use of safety tools. It can be noticed that Amman quarries are more responsive to safety-tool availability, use, and enforcement than Irbid quarries. Although most quarries make available and provide workers with safety tools, the usage and enforcement of the use of such tools are limited. Regarding personal health issues, results indicate little concern towards employees' health issues. Although there is a slight difference between managers and workers responses, results indicate the availability of first aid kits nearly all the time (Q5). However, no periodic medical checkup is performed or scheduled for quarry employees (Q6). Moreover, health problems are rarely considered in assigning employees to work tasks (Q7). For all accidents resulting in serious injuries, the injured were taken to hospital by Civil Defense cadres in a timely manner (Q8).

### 3.2.2 Technical Safety

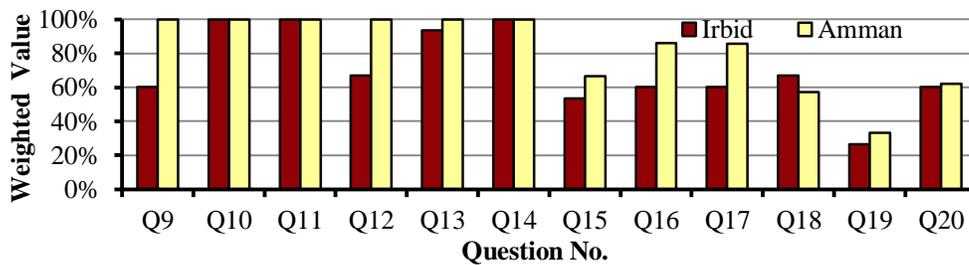
Technical safety covers issues like the presence of safety features, maintenance of machines, adopting safe practices when using explosives, maintaining safe site and clearing of depress, and maintenance of safe and clear routes for machine and workers. These issues were covered in questions 9 through 20, shown in Figures 3(a) and 3(b), respectively. As can be seen in the figures, the results indicate insignificant differences among the workers' and managers' responses to most of the questions, with slightly better technical safety conditions in Amman quarries than those of Irbid quarries.

Question 9 asks about the presence of fire extinguishers in the quarry site. The survey results indicated that while all quarries in Amman governance keep fire extinguishers on the quarry site, only 60% of Irbid governance quarries do so. Questions 10 and 11 ask about the safe storage and usage of explosives and the precautions undertaken including the use of explosive experts. The results indicate compliance of quarry managers with safe storage and usage of explosives.

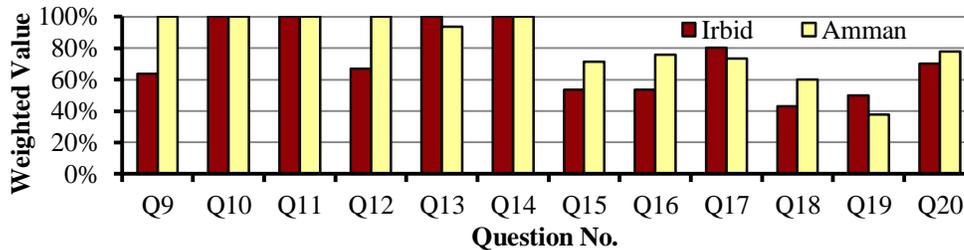
Questions 12, 13 and 14 investigate the adequacy of equipment and machine safety features, the proficiency of equipment operators, and the adequacy of maintenance programs. It is apparent from responses to Question 12 that workers and managers agreed that safety features such as breaks, lights, warning signals, and conditions of tires are always available in Amman quarries, and less available (about 60%) for those in Irbid quarries. However, Question 14 indicated that workers and managers in both

Amman and Irbid quarries report adequate and proper maintenance of used machines. Question 13 investigated the proficiency of mechanisms operators, indicating the machine operators have adequate skills and proficient and pose little safety risk.

Question 15 inquires about the importance of supervising and monitoring movement of dangerous machines. In general, the results indicated inadequate supervision, as the weighted average of managers and workers in Irbid quarries stands at 50%, and less than 70% for Amman quarries. Question 16 asks about the designation and maintenance of distinct routes for the movement of trucks and equipment away from the movement of labor. Results clearly indicate a significant difference between workers' and managers' responses in Amman and Irbid quarries: Most Amman quarries (weighted average of 70% to 80%) have well-maintained equipment and routes while Irbid quarries average only 50% to 60%.



a) Technical safety as reported by manager.



b) Technical safety as reported by workers.

Figure 3: Weighted percentages of applying of technical safety.

Question 17 asks about the safe location of workers during the crushing of rock masses. Crushing of rocks involves the use of heavy equipment and may result in flying debris that may harm nearby workers. Responses indicate that not enough attention is paid to keep workers far away from such dangerous operation.

Question 18 inquires about the presence of specialized corridors for worker movement within the site. The weighted percentage for Amman quarries is less than 60% of the time, while those of Irbid quarries vary from 40% for workers' responses to about 75% for managers' responses.

Question 19 investigates the presence of fences around ditches and dangerous working areas. Responses show relatively low weighted percentages of times for both

Irbid and Amman quarries. There was a difference between responses of workers and managers, with workers indicating better responses. It can be concluded that fences are insufficiently used to protect workers from approaching dangerous areas.

Criteria for selection of workers are the subject of Question 20. It is alarming to find out that managers' claim that only 60% of workers are selected based on qualifications and experience. Workers, on the other hand, indicate that over 70% of the workers are selected on qualifications and experience.

### 3.2.3 Safety Awareness

Safety awareness was measured through questions on issues including conducting safety awareness programs, management commitment to safety awareness, conducting accidents and evacuation drills, first aid training, cooperating with Civil Defense, and awareness of accident and emergency procedures.

The responses clearly indicated a lack of safety awareness among the workers and managers in both Amman and Irbid quarries. Question 21 asks about the existence of safety awareness programs for new workers. Only 40% of workers admitted the presence of such program. However, the weighted percentages of managers' responses were much higher than that of workers for both Irbid and Amman quarries. The weighted percentage of time, according to workers and managers responding to questions 22 through 27, is zero. This means the lack or non-existence of: (1) leaflets or posters about safety in quarries, (2) prior exercises on how to deal with incidents in the quarry, (3) training on how to deal with hazardous materials, (4) drills for evacuation when major accidents occur, (5) coordination between the quarry owners and civil defense devices to give training courses on occupational safety, and (6) safety inspection by public authorities.

## 4 CONCLUSIONS

Results show compliance with health and technical safety requirements are applied to various degrees in all studied quarries. However, compliance with safety awareness requirements is lacking. Results indicate that compliance with safety measures correlates with the level of workers education and working experience. This is also reflected in the frequency and the severity of injuries.

## References

- Conchie S., Supervisors' engagement in safety leadership: Factors that help hinder, *Safety Science*, 51, 109-117, 2013.
- Ersoy, M., The role of occupational safety measures on reducing accidents in marble quarries of Iscehisar region, *Safety Science*, 57, 293-30, 2013.
- Maier, A., Evaluation of the kind of hazards and risks encountered with explosives when blasting in quarries-A simple concept, *Proceedings of the First World Conference on Explosives and Blasting Technique*, Holmberg R. (ed.), 59-62, Munich, Germany, 2000.
- Patrick, W., and Yosia, R., Skills for managing safety risk, implementing safety task, and developing positive safety climate in construction project, *Auto. in Const.* 34, 92-100, 2013.
- Yarahmadi, R., Bagherpour, R., and Khademian, A., Safety risk assessment of Iran's dimension stone quarries, *Safety Science* 63, 146-152, 2014.